Limited conifer regeneration but widespread regeneration of aspen seedlings following the Cameron Peak fire, northwestern Colorado

SOUTHERN ROCKIES FIRE SCIENCE NETWORK

Research Brief · September 2026

Background

Post-wildfire conifer regeneration is declining in many ecosystems across the western United States as a result of altered fire regimes and climate change. As wildfires become more frequent, extensive, and severe, seed sources are increasingly depleted either because they have not had time to develop or because remaining living trees are too far away to provide seed. When seeds do fall, they often contend with hot, dry post-fire climate conditions which make it difficult to germinate and grow. The decline of conifer regeneration offers the opportunity for colonization by other species.

In the Southern Rockies, aspen is known to proliferate following fire by resprouting from living underground tissue. However, relatively little is understood about the potential for aspen to regenerate by seed in this region. Aspen seeds are wind dispersed, and thus are able to travel further from a living seed source than conifer seeds. High-severity burn patches which may lack conifer seed sources are then possible sites of aspen regeneration, additionally offering the full to partial sun necessary for aspen establishment. Understanding when and where aspen regenerates by seed will help managers plan for climate-adapted, fire-resilient forests.

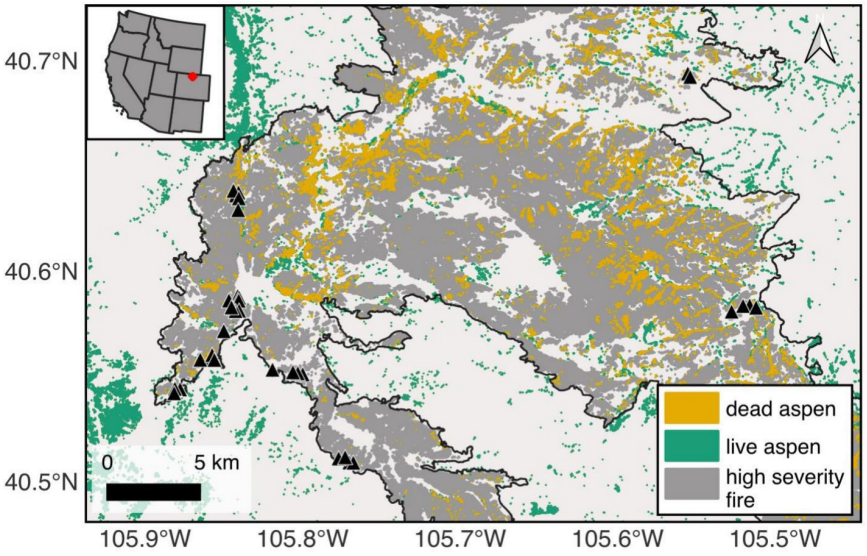


Figure 1. The study area, study sites (triangles), and the distribution of live and burned aspen. The inset map displays the study area relative to the Western United States

Research Overview

The 2020 Cameron Peak fire is the largest wildfire in Colorado's recorded history, burning 845 km^2 across a wide elevational gradient. Notably, 40% of the fire area experienced pre-fire bark beetle outbreaks, which caused widespread conifer mortality. In 2022, researchers collected and analyzed field data within the burn scar from 32 sites in upper montane and subalpine forests which burned at high-severity and did not contain aspen prior to the fire. The analysis focused on understanding patterns of tree regeneration by seed across the landscape based on biophysical variables.

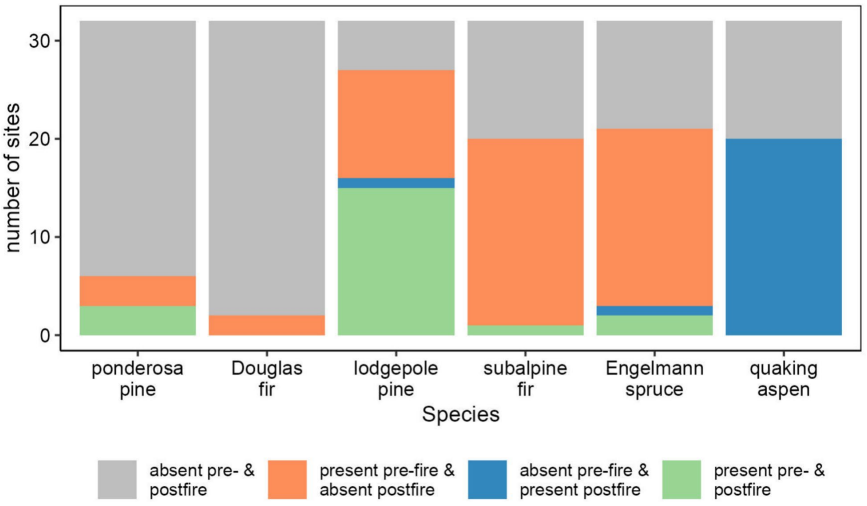


Figure 2. Patterns of postfire seedling presence by species and pre-fire species presence in the overstory

The study evaluated:

- **Objective 1:** How does postfire regeneration of conifers and aspen vary across sites?
- **Objective 2:** How are aspen and conifer seedlings distributed within sites?
- **Objective 3:** How do site and microsite conditions influence aspen seedling establishment?

Key Findings

Finding 1: Aspen colonize severely burned areas by seed and occur at greater densities than conifer seedlings.

Aspen seedlings and conifer seedlings (of any species) occurred at the same proportion of sites (62%), but aspen densities were higher on average. Lodgepole pine was the most abundant conifer observed in the surveys, likely due to its regenerative trait of serotinous cones, while other conifer species observed are dependent on seed dispersal from live trees. The conifer species that did regenerate largely mirrored the pre-fire community, showing conifers rarely colonize new areas. Compared to other studies in the West, the rate of aspen regeneration at these sites was relatively high. This can likely be attributed to the sampling design, which only sampled high-severity, high-elevation sites.

Finding 2: Aspen and conifer seedlings co-occur at sites, signaling competition for shared resources as seedlings grow.

The density of aspen seedlings was significantly correlated to the density of conifer seedlings. This spatial clustering indicates that both taxa respond to shared local environmental conditions that are favorable for seedling germination. Because aspen seedlings clustered near conifer seedlings and often outnumbered conifer seedlings, competition for resources between aspen and conifers, differences in regenerative traits, and rates of survival and growth will determine forest trajectories.

Finding 3: Aspen seedling density is highest in cool and wet landscape positions and microsites including higher elevations, concavities, on bryophyte (e.g., moss) substrates, and near large woody debris.

At the landscape scale, aspen seedling occurrence and density increased with elevation, despite most pre-fire aspen occurring at lower elevations. Higher-elevation sites provide cooler summer temperatures, greater snowpack accumulation, and prolonged moisture retention, which alleviates drought stress for seedlings. Within sites, aspen seedling densities were highest in microsites that trap seeds and moisture and can provide nutrients. Aspen seedlings were 20.5 times more likely to establish on bryophytes than on any other substrate type, and preferentially established in concavities and near large woody debris. The importance of microsites seemed to be greater at lower elevation, harsher sites.

Management Implications

- Researchers found poor overall conifer regeneration across upper montane and subalpine forests in the Cameron Peak burn scar. While aspen regeneration by seed occurred at higher densities, less than half of the sites with aspen seedlings met local USFS requirements for aspen restocking. Without human intervention, conifer regeneration will likely remain limited across the system and some areas may transition to low-density aspen woodlands or mixed conifer-aspen stands.
- Aspen can be expected to increasingly shape postfire forest communities. Broadleaf species like aspen hold more moisture than conifers, and can support lower burn severity in subsequent fires. With successful establishment, new stands may also resprout to create a fire-resilient system. Further, aspen stands benefit biodiversity and increase retention of carbon-rich soil organic matter through litter quality and plant-soil feedbacks.
- Microsites for seedling establishment will likely increase in importance as western climate becomes warmer and drier. Conserving microsites should be prioritized through responsible recreation and forest management. Foresters may want to utilize or mimic concavities or large woody debris when planting trees for reforestation.

Additional Information

This brief is based on the following article: Carter, S. V., & Hart, S. J. (2026). Limited conifer regeneration but widespread regeneration of aspen seedlings following the Cameron Peak fire, northwestern Colorado. *Fire Ecology*, *22*(1), 16. https://doi.org/10.1186/s42408-025-00444-6

This brief was written by Elizabeth Buhr and produced for review by the Southern Rockies Fire Science Network.

For additional information, contact: Sarah Hart, Sarah.Hart@colostate.edu

READ THE FULL PAPER HERE!